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Development of an approach to quantify thermal stress of livestock in Germany

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Agriculture will face two issues among others in the future. On the one hand, food demand will increase due to a rising world population. On the other hand, the air temperature will rise and extreme weather events will become more frequent on a global mean. Especially heat stress conditions have a negative impact on productivity, health, product quality, fertility of livestock and causes high financial losses of the agricultural sector. As the food chain has to be guaranteed in the future, livestock production needs to be improved and intensified. In human-biometeorology, thermal indices are successfully used to forecast and prevent heat stress conditions. However explicit characteristics to quantify thermal stress of livestock are not proven. Therefore a model to calculate the energy budget for european cattle was established. Energy fluxes by metabolism, convection, radiation, respiration, diffusion of water vapour and sweat evaporation between animals and their thermal environment are implemented in an user-friendly software. The meteorological input variables are restricted to air temperature, relative humidity, wind speed and global radiation, as these variables are measured by default at official weather stations. Additionally, the model contains individual parameters such as sweat rate, respiration rate, emissivity, albedo and body weight of the animal. As cattle are homoeothermic, a highly negative or positive output of the energy budget implies cold and heat stress, respectively. If the energy budget is close to zero, the animal is in thermal equilibrium with its environment and does not experience thermal stress. The calculation of the energy budget is the first step in order to develop a biometeorological index for livestock to detect and quantify thermal strain conditions. This approach can be used to forecast heat and cold stress, enhance performance, improve health and develop husbandry conditions.